## Climate Change

Maps of PNW from **presentation on "Is the climate of the Pacific Northwest Changing" - JISAI Climate Impacts Group, University of Washington**[1]

- Temperature trends since 1920 (°C per century)
- Precipitation trends (cm per century) since 1920
- Tends in timing of spring snowmelt (1948 - 2000)
- PNW average temperature (1900 - 2000)
- CO2 level (1900 - 2000)
- Northwest Warming -trend and forecast 1900 - 2040 –> **The average temperature predicted by seven global climate impact models show an increase (including the 0.5 deg. F increase over the past century) of 3 deg. F by 2020 and 5 deg. F by 2050.**
- Table with range of climate change scenarios 20th c. - 2040
- Conclusion:
  – Lots of evidence that we are on the path of global and regional warming
  – PNW especially vulnerable to loss of snowpack (agriculture, municipal, and industrial water supply, fish, hydropower)
  – Minimize risk by planning now - start adapting

**Climate Solutions Special Report[2]:**

*Scientifically credible scenarios show:*

- Winters with substantially more rainfall, and summers with larger number of extremely hot days;
- More frequent and destructive flooding and mudslides
- A disrupted annual water cycle in which snowpack - on which the Columbia and other Northwest rivers depend during the summer - shrinks by half;
- Droughts coming twice as frequently by 2020 and three times more often – three years out of every 10 – by 2050;
- Salmon runs diminished or lost to an even greater degree than at present;
- Water shortages which choke hydroelectric power production and irrigated farms;
- Ski seasons and runs shortened as snowline retreats to higher elevations;
- Forest cover in Oregon and Washington sharply reduced, with forests retreating from the eastern slopes of the Cascades;
- More numerous and intense forest fires and pest infestations, bringing major shifts in tree species distribution across the Northwest;
- Human health impacts from worsened air pollution, increased heat waves and population of disease-carrying insect populations;
- Rising seas which undermine coastal bluffs, cause landslides, drown highways and waterfronts, bring higher storm surges and cover tidal marshes vital to fish and birds.

*Conclusions from different models:*

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1 http://jisao.washington.edu/PNWimpacts/

2 Direct text from this report is included in this summary; please see the report for its cited references for the factual information. http://www.climatesolutions.org/

- UW's JISAO seven models, when averaged, show
  – an **increase of 3 def F** (including the 0.5 deg F that has already occurred over the past century) **by 2020 and 5 deg F by 2050**. Even 0.5 deg F has a big impact, as seen by the mud slides and dry summers we already experience from the 0.5 degree increase that come with El Nino years.
  – tendency towards wetter winters and drier summers, with extreme cases of winters with 22 % more precipitation, and summers with 26% less by 2050. Overall the models suggest **a 9% increase in winter precipitation and 5% decrease in the summer by 2050.** Under any scenario, more heat brings more evaporation, which will make for drier summer conditions.
- PNNL's L. Ruby Leung developed the most sharply focused regional climate model, which is able to include key topical geographic features like the Cascades.
  – in general it shows **temperatures increasing fastest in mountain areas, which has serious implications for snowpack.**

*Greatest potential danger from climate change in the PNW is the way warming might alter water flows.*

- If the climate develops in the way the scenarios suggest, then **sometimes in winter and spring there will be too much water, causing floods and mudslides, and often there will be too little water in late summer and fall**. Forests will dry out, becoming more vulnerable to catastrophic fire and disease outbreaks. Salmon will find new obstacles to spawning in swollen winter streams that wash out nests, as well as overheated summer streams with too little water. Low flows will also choke hydropower production and irrigated farms. El Nino and other natural climate variations, which already bring warm, dry spells to the Northwest every few years, are regarded as "dress rehearsals" for global warming. The dry spells will be more intense due to increasing evaporation and changing runoff patterns.
- **Global warming may well be warming up El Nino by heating the sea surface.** While this conclusion remains controversial, El Nino research pioneer, Keith Trenberth, climate analyst at the US National Center for Atmospheric Research, has 20 years of statistical models of El Nino that show odds are only one in 2,000 that purely natural causes are behind the recent surge of El Ninos.
- **Global warming threatens to eliminate half the Northwest snowpack resource, as less winter precipitation falls as snow and more as rain.** Snow that does accumulate will vanish more quickly, since nothing melts snow faster than rain. **Freezing levels will rise; the PNNL model shows average Cascade snowlines rising from its current 3,000 feet to 4,100 feet by 2050-80**. More snow may pile up in regions where the temperature stays well below freezing, such as above 9,000 feet, but the loss of snowpack in far extensive lower elevation areas will more than cancel that out. **The PNNL model shows the volume of water stored in Northwest snowpack shrinking by 50% by 2050-80.** Many Northwest mountain areas in the 3,000-6,000 foot range will become snow-free. **Only 40-60% of today's average March snowpack is projected to remain in most of the Cascades and interior eastside mountains of Oregon and Washington. Most slopes on the western Oregon Cascades retain 20% or less of current snowpack.**
- Earlier runoff will result from the shrinking snowpack and warmer, rainier spring

months. Rainfall-driven rivers are likely to see increased flows in the winter and decreased in the summer, and eastside rivers will also flow more like the westside rainfall-driven rivers. Streamflow will be reduced in July and August when it's most needed. In the PNNL scenario for 2050, runoff in Oregon and Washington will surge well above current levels through winter. Total annual streamflow will be higher but the peak will be sooner. In Oregon runoff will peak in March, instead of May as it does now. Around the beginning of April it will dip below the present amount and remain significantly lower until September. For Washington, the runoff peak will move from its current peak in May and June to April and be completed by early May, then stay lower all spring and summer.

- The Northwest experienced droughts in 1987-88 and 1992-94, which resulted in low streamflows. Among the consequences were $575 million in added expenses to Bonneville Power Administration in 1992-93, mandatory lawn watering restrictions in Seattle in 1992, and 1994 streamflows 10% below the target for salmon on the Columbia and 25% below on the Snake River. **Such severe low flow events are now expected 4 years out of every 40; by 2020 under a middle of the road climate scenario, odds are for 8 drought years out of every 40 and by 2050, 12 out of every 40.** That represents a doubling of the risk in 20 years and a tripling of the risk in 50 years.
- The large reservoirs on the Columbia are able to store about one-third of the river's annual flow, but they still won't be large enough to store water from year to year or to compensate for the loss of half the snowpack. **In heavier runoff years, the reservoirs fill to capacity, limiting their ability to control floods and dam operators will be forced to spill water early. With low snowpack, there will also be less water to release in the extended summer period the region will experience from the higher temperature and greater evaporation.**
- One of the scenarios developed by JISAO and based on global modeling done by the Max Plankt Institute**, projects that the Columbia-Snake hydro systems , which now meets firm energy requirements 96% of the time, would slip down to 82% by 2050. That signals the need for large new regional investments in energy efficiency and generating capacity**. "Even a 10% decrease in Northwest streamflows could result in the loss of generating capacity equivalent to what is needed to keep the lights on in Seattle." [3]
- **For irrigation, reliability drops even more. For example, the Upper Snake now reliable provides water to farmers 97% of the time; by 2020 that is expected to drop to 84% of the time. The Middle Snake, now reliable only 86% of the time, drops to 70%. While the growing season may be longer, the higher temperature will increase the need for water while the water supply will be severely constricted.** "In low water years, some crop producers are taking buyouts because they can't get the needed water. "In Idaho, marginalized farms are going out of existence and reverting to grasslands,' said Philip Mote, a research scientist with the UW Climate Change Group. 'There simply isn't enough water to preserve agriculture over the number of irrigated acres we have

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[3] Craig Welch, "Less Snow Might Fall, State Scientists Predict, But Who's Listening?" Seattle Times, P. A1, July 26, 2002.

now.'"[4]

- Higher rainfalls over the past century have already been documented, including a 10% increase in precipitation and a 20% increase in extreme precipitation events in the U.S. **Rainfall has increased 20% at a number of weather stations in the Oregon Cascades and western Washington, which are also in the region of the most slide-prone reaches of the U.S.**
- With warming temperatures, forests will become generally drier during summers because increased evaporation will wring out soils; **dryness will promote fires, and with warming temperatures, with greater intensity and frequency. Trees stressed by thirst and heat are more susceptible to pests and disease.** Forests living on the fringes of their geographic range will decline or disappear across wide areas. **Both Oregon and Washington could lose 15-25% of total forest cover, mostly conifers on the drying lower east slopes of the Cascades., to be replaced by sagebrush steppe and grassland. Douglas fir, which requires a winter chilling, will likely vanish from the Coast Range of Southern Oregon and Northern California under expected warming**.
- **Greater storm surges and rising sea levels will erode coastline and beaches and increase chances of landslides. Natural soil settling patterns in communities along inland straits will find themselves prone to flooding and storm surges.** The Puget Sound is settling by six inches per century in Seattle, nine inches around Tacoma, and five inches around Olympia, and with sea levels expected to rise as high as 20 inches by 2100, many areas around the Puget Sound and other coastal communities are vulnerable. Even a one-foot rise would force a costly realignment of Oregon's Highway 101, disrupting businesses and forcing people to move. The British Columbia's coastline is experiencing upward pushes of the earth, however, that are expected to cancel out as much as 16 inches of the rising waters.
- "One climate model predicts the Arctic ice cap will vanish entirely during summers by 2050. Four other models, however, say some ice will remain. 'Eventually the whole cap will disappear. If not by 2050, sometime after that,' says John Walsh, an Arctic scientist at the University of Illinois - Champaign-Urbana." [5]
- "A Northwest Passage threading 900 miles through a tangle of islands about 500 miles north of the Arctic Circle could be open for one or two months a year five to ten years from now, the U.S. Arctic Research Commission concluded. So far only icebreakers and specially hardened ships have made it all the way from the Atlantic to the Pacific through this northwest route. The northwestern path through the ice would cut the travel distance between Europe and Asia by 6,800 miles, compared with the standard route through the Panama Canal. For supertankers, which now must sail all the way around Cape Horn at the tip of South America, the trip would be shortened by 11,800 miles. According to the Arctic commission, the new summertime sea lanes will open the way for 'significant navigable opportunities in the Arctic.' [However]..it is unlikely that large amounts of Alaska or Canadian oil or gas would be shipped through the Northwest Passage. Even

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4 *Ibid.*

5 Robert Boyd, "Rapid Ice Melt May Open Up Fabled Northwest Passage," Seattle Times, p. A1, November 10, 2002

though the trip would be much shorter, tankers would face higher costs for insurance, double hulls to prevent leaks and the unpredictability of the weather."[6]

*Conclusions:*

- Part of the best strategy is adaptation to the negative impacts the region is likely to experience, requiring a range of public policies to be taken, such as water conservation and increased focus on slide and flooding hazards in land use and transportation, to added emphasis on salmon recovery measures.
- Also must find a way to alter global trajectories, given the degree of vulnerability the Northwest has to climate affects beyond our control. Leading by example may be the best, most realistic option. Building public awareness and self-awareness of impacts and opportunities should be the first step.
- **CO2 emissions from energy-related activities could be reduced by increasing energy efficiency and using non-fossil sources of energy. The energy intensity, Btu per person must decline to compensate for population increases. This requires new energy efficient technology and greater adoption of this technology by the marketplace**. The other option is to use fuels that emit less CO2 per unit of energy provided, such as and renewable energy sources - hydro, photovoltaics, biomass, and geothermal. Other solutions must address transportation energy use, which is the both the largest greenhouse gas producer and fastest growing sector. Washington's CO2 emissions in the year 2010 could from light duty vehicles could be reduced by 7.3 million tons, or 24% , if average vehicle efficience increased from the projected level of 20.3 to 26.7 miles per gallon. The NWPCC estimates there are approximately 13 million MW of cost-effective electricity savings available in the Northwest. Increasing the efficiency of electricity use in buildings will help.[7] *Bar chart of projected carbon emissions from 1990 to 2010, showing contributions by buildings, industry & transportation, and 7% reductions for Kyoto Protocol, and 60% scientists say are needed to stabilize greenhouse gas concentrations.*

**Other Conclusions**, **Factors to Consider:**

- "Nobody has really started thinking about this seriously," says Bill Pennell, director of the global-environmental change division at the Pacific Northwest National Laboratory in Richland. "Most are driven by shorter-term goals and this is kind of out there on the horizon. **The reaction has been 'This is interesting, but it's not happening on my watch.' But it's happening sooner than people might think."**
- **Doing nothing comes with a cost all its own**, since if climate change is happening, its effects will come soon, warns Edward Miles, head of University of Washington's Climate Impacts Group. Even people who question their projects need to weigh the impact of doing nothing. "What's the probability that we are correct?" Miles asked. "At what point do we need to buy some insurance? For us, the best insurance is planning."

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6 *Ibid.*

7 James D. Kerstetter, PhD, "Greenhouse Gas Emissions In Washington State: Sources and Trends" Washington State University Cooperative Extension Energy Program for Washington State Community, Trade, and Economic Development, Energy Policy Group. August 1999. http://www.energy.cted.wa.gov/papers/wa-ghg99.htm

For example, even the most conservative estimates show population growth will increase demand and competition for drinking water, and it takes 20 to 25 years to change a water system, Miles says. Seattle Public Utilities is trying to identify how climate change could affect the city's snowmelt dependent drinking water supply. The agency is working with Miles' group to study in more detail how lower snowpack could affect water supplies in the Cedar and Tolt watersheds, the source of the city's drinking water.

- "Land-use change, such as farming, irrigation and urban sprawl, appears to be a major factor contributing to climate change, according to a new report from a Colorado State University researcher released by NASA Tuesday. ...Roger Pielke, state climatologist and CSU atmospheric researcher, found land surface changes caused by humans in places such as North America, Europe and Southeast Asia, redistribute heat regionally and globally within the atmosphere and may actually have a greater impact on climate than that caused by the combined effects of greenhouse gases. Those land-use changes have unpredictable consequences, Pielke said. 'We're altering the climate in adverse ways.'... Types of land surface strong influence how the sun's energy is distributed back to the atmosphere. For example, if a rain forest is replaced with crops, there is less water evaporation, which leads to warmer temperatures in that area. The reverse is true when dry areas add water through irrigation. 'Our work suggests that the impacts of human-caused land-cover changes on climate are at least as important, and quite possibly more important, than those of carbon dioxide,' Piekle said. Many land use changes cannot be reversed, said Steve Running, ecology professor at the University of Montana, a member of the research team... 'We're not trying to replace (the important greenhouse gases), but instead bring in an additional variable that has been ignored.' Any plan geared to tackle climate change must include reducing greenhouse gases and better land management, he said. There are other contributing factors to climate change, such as the use of aerosols and nitrogen deposition, that need to be considered as well, Piekle said. 'We have to look at the climate issue holistically.'" CSU atmospheric researcher Kevin Gurney, who also consults to the World Wildlife Federation on how planting trees and deforestation affects greenhouse gases, says "he's not ready to concede that land-use change is as important to climate change as greenhouse gases because the impacts cannot be weighed on the same scale. '[Land-use change] hadn't entered the radar screen [at international conferences] because the work wasn't done,' Gurney said. In the future, land-use concerns need to be incorporated in climate change protocols at a level equal to the impact it has on climate change. That level of impact has not been shown, Gurney said."[8]
- "Old growth forests have massive carbon storage," says William Winner, Oregon State University professor of botany and plant pathology. "There's more Pacific Northwest old growth than any other ecosystem in the world." Winner explains that forests can absorb (through photosynthesis) and emit (as part of respiration) CO2, though the age of a forest determines if it's a source or a "sink" in the global carbon balance. Seedlings are a big source of gas, since they don't have a lot of leaf area. In the Northwest, the 'cross-over' point, from carbon dioxide source to sink, is in the 40-60-year old range. "Past that point, forests become strong sinks of CO2," he said. Sports Utility Vehicles average 4,500 pounds of carbon emitted a year, while an old-growth tree, on average, gains 154

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[8] Sally Bridges, "Heating Up the Earth: The way we use land is altering weather patterns, CSU scientist says," On-line Fort Collins Coloradoan, October 2, 2002.

pounds of carbon a year, so it takes 30 old-growth trees to offset the emission from an SUV, the number found over a 2-1.2 acre stand, he said. (Other factors, such smaller trees, soil, etc. are not factored into the estimate.) Vehicles emit about half the CO2 emissions from petroleum in this country. Winner said (the rest coming from coal- and natural gas-fired power plants and other sources). So trees and forests can only do so much to reduce the greenhouse gases blamed on global warming... When asked about livestock, Winner pointed out they produce methane, which is "a much more powerful warming agent than CO2." "It's a whole social system problem, and it will take a whole social system to fix it," the professor said. There's also a need to "create economic systems that give us the true cost of the resources we use. We might think differently about how we build houses, use the wood make paper, if we had to pay the external costs."[9]

**Business Risks from Climate Change beginning to be acknowledged:** [10] [11]

- The **Carbon Disclosure Project** (CDP), a collaboration of more than 30 major institutional investors who collectively represent more than $4 trillion in assets, has released a report that says investors who fail to take into account of account of climate change in their asset allocations and equity valuations face serious investment repercussions over time. The report is based on the largest survey yet to analyze a company's exposure to climate change, through the impact so extreme weather and the regulation of greenhouse gas emissions. **Presenting those factors in terms of the value of shareholdings in corporations worldwide, the survey of the 500 largest global companies by market capitalization found that 80% of those who responded acknowledged the importance of climate change as a financial risk, yet only 40% at best were taking any action to address the risks and opportunities.**
- Besides the obvious emissions-intensive sectors such as oil, gas, and electric utilities, companies in a wide range of other sectors, including financial services, transportation, semi-conductor, telecommunications and electronic equipment, will all be deeply affected as well. Tessa Tennant, Chairperson of the CDP, stated "The financial consequences of climate change are almost certain to grow, and the information deficit for investors will prove costly."
- On a sector level, the CDP's survey revealed that different industries vary widely in their degree of risk exposure and how sophisticated they've developed their risk management response. For example, in the banking industry, climate-change induced loan impairment of 10 % could result in a 29% drop in share prices for banks without adequate carbon risk management. And the rail industry illustrates how supply chains will also feel the impacts of climate change. The report concluded that a drought-induced reduction in

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9 Barney Lerten, "Old Growth Trees and SUVs: OSU researcher makes worrisome link," Bend Bulletin, February 4, 2003

10 Derek Reiber, "Show Me the Carbon: The financial world takes notice of climate change as a business risk, while a new clean energy report predicts a brighter future," Tide Pool, posted February25, 2003

11 "SEC Sends Mixed Message on Utilities' Reporting of Climate Risks," Greenwire, February 28, 2003

U.S. agricultural commodity shipments of 5% would depress revenues between 7.5% and 10.5% of net income.

- Perhaps the report's most important finding shows that companies who are getting ahead of the curve in managing the financial risks associated with climate change are sure to perform better in the future. They may even gain a competitive advantage, both in cutting costs and risks; the report cites British Petroleum for cutting its annual carbon dioxide emissions at its plants by 10 million tons, which resulted in $650 million in savings.
- **The Securities and Exchange Commission is beginning to weigh in on requests by activist shareholders with stocks in several utility companies for votes on resolutions for electric utilities to outline the economic risks associated with their carbon dioxide and other pollutant emissions.** So far the SEC's message has been mixed, suggesting it will not bring an enforcement action against Cinergy Corp. if the company spurns the request for a shareholder vote, citing the request as undue influence in ordinary business activities, while rebuffing a request from PG&E National Energy Group to deem a similar shareholder request inappropriate.
- Meanwhile, while other sectors are experiencing either slow or negative growth**, clean energy, including wind energy, solar power, and fuel cells, are reporting double-digit annual growth rates.** Clean Edge, a San Francisco-based research and consulting firm predicts that "Combined, these high-growth technologies will grow by nearly an order of magnitude, – from just under $10 billion today to $89 billion by 2012– offering significant economic opportunities for companies, investors, and governments pursuing clean energy goals."
- A recent commentary in The Oregonian hyped that much of the leadership for the new hydrogen economy could come from the Pacific Northwest, taking advantage of the region's low cost hydropower. By using low-cost electricity generated by the Columbia River's massive dam system, water could be electrolyzed into its two components – hydrogen and oxygen. That hydrogen could then be stored in fuel tanks all around the region, fueling a "hydrogen highway" up and down the West Coast. The strong potential for wind power, solar power, and geothermal in the Pacific Northwest should also be exploited, argued Jack Robinson, the op-ed piece' author.